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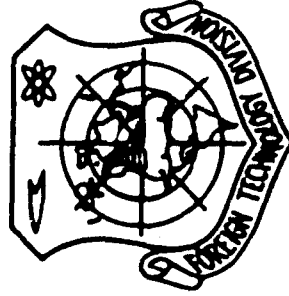
## FOREIGN TECHNOLOGY DIVISION



QUALITY REQUIREMENTS OF MOTOR OILS FOR MODERN  
TRACTOR DIESEL ENGINES

by

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## EDITED TRANSLATION

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By: S. G. Arabyan, G. P. Belyanchikov,  
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English pages: 9

Source: Vsesoyuznoye Nauchno-Tekhnicheskoye  
Soveshchaniye po Prisadkam k  
Mineral'nym Maslam, 2nd, 1966.  
Trudy (Second All-Union Scientific-  
Technical Conference on Additives  
for Mineral Oils, 1966. Trans-  
actions), Izd-vo "Khimiya," Moscow,  
1968, pp. 268-273.

Translated by: M. Olachea/TDBRS-3

UR/0000-68-000-000

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FTD-HT-23-283-70

Date 12 June 1970

## QUALITY REQUIREMENTS OF MOTOR OILS FOR MODERN TRACTOR DIESEL ENGINES

S. G. Arabyan, G. P. Belyanchikov, and N. V. Yershov

Between 1959-1965 the parameters of Soviet tractor diesel engines were drastically changed. Thus, the displacement of the most widely used engines was increased by 45%, the r/m and mean effective pressure by 18%, with a simultaneous decrease in weight per unit volume by 34%. In conformity with developmental planning in diesel tractor construction a further increase by 30% in volumetric thrust, a reduction of metal requirement by 10%, and an increase in the service life of the engines prior to the first major overhaul up to 6,000 h are projected.

In order to obtain the planned technical and economic indicators for newly designed tractor engines, it is necessary, in addition to solving the technological and design problems themselves, to improve the operational properties of diesel oils.

Regardless of a certain improvement in the quality of diesel oils, their operational properties at present do not satisfy the demands of the tractor engines. Our agricultural tractor fleet operates basically on diesel oils with additives TsiATIM-339, AzNII-7 (Premium type) and VNII NP-360 (Heavy-duty type).

Diesel oils with additives VNII NP-360, MNI IP-22k, and BFK do not fully guarantee the reliable operation of the modern tractor engines YaMZ-238NB, SMD-14, D-37M, D-50, AM-01, and others, while oils with additives TsiATIM-339 and AzNII-7 are not at all suitable for engines of this type.

Similar engines in most foreign countries use motor oils of the Series 1, 2, and 3 type, which almost eliminate carbon and lacquer deposit on the engine parts, almost eliminate carbonizing of the piston rings, neutralize the harmful effect of combustion products of sulfurous fuel, and enable decreasing the size of the crankcase and increasing the oil change interval to 500 h. By using such oils it is possible to lengthen considerably the overhaul life of the engines and to bring about a two-fold decrease in oil consumption.

Within recent years in VNII NP, BashNII NP, NATI and IKhP AN Azerbaijan SSR a number of projects have been conducted on creating a rational classification of motor oils and methods for testing and evaluating their operational properties.

The projects made it possible to determine the level of requirements levied on oils by engines of different classes and purpose, to create additive compositions for motor oils of different groups, and also to recommend methods of accelerated testing of oils on one-piston devices, which enable sufficiently accurate determination of the group (type) of oil according to its motor properties.

At the same time in VNII NP, IKhP AN Azerb. SSR, NATI, VIM and at tractor plants numerous tests were conducted with test specimens of diesel oils under bench and operational conditions with various additive compositions corresponding to the requirements of the specially developed classification. Oils and additives from Soviet Industry were subjected to testing and were compared with samples of diesel oils with additives from the British firm "Monsanto."

In using diesel oil DS-11 with 3% TsiATIM-339 additive and

sulfurous fuel in tractor engines of the old D-54 and KDM-46 models intensive carbon formation and massive carbonizing of the piston rings occur.

An increase in the concentration of additive TsIATIM-339 up to 5% or the addition to an oil with 3% TsIATIM-339 additive of 2% AFB additive eliminated burning of the rings; however, here the great amount of deposits, especially in the region of the piston rings, was retained. The deposit mass on the piston constituted 20-45 g on the D-54 engine and 30-65 g on the KDM -46 engine. Diesel oil DS-11 with 5% AzNII-7 additive also showed unsatisfactory results in carbon and lacquer deposition and in burning of the piston rings.

Thus, diesel oils with the indicated additives do not guarantee the reliable operation of tractor diesels of the older models when they are run on a sulfurous fuel.

Considerably better results were obtained for oils containing 6% of additives VNII NP-360 and BFK: no carbonizing of the piston rings was observed, there was a decrease in fouling of the engines by carbon deposits, and there was approximately a two fold decrease in wear of piston rings and cylinder sleeves.

According to the data of the operational tests conducted by VIM, the use of DS-11 oil with 6% of additive VNII NP-360 provides a service life for the older model engines without disassembly of 3.5-4,000 h, while DS-11 oil with a 3% additive of TsIATIM-339 provides only 1.5-2,000 h.

Modern supercharged tractor engines D-37, SMD-14, D-50, and others, operating under accelerated modes on sulfurous fuel, cannot under bench conditions normally complete even 500-800 h on oils with additives TsIATIM-339 and AzNII-7, due to burning of the piston rings. Using oil with additive VNII NP-360, even though contamination of the engine by deposit is reduced (Fig. 1), nevertheless the tolerable amount of deposit is quite low, especially in the slots of the piston rings.

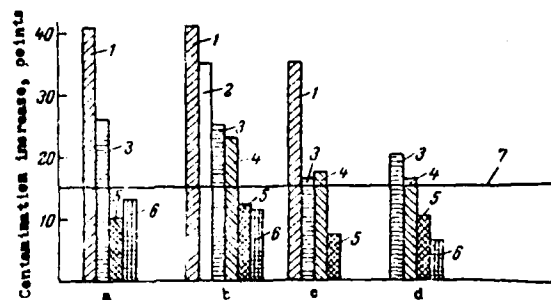


Fig. 1. Effect of the quality of different oils and additives on engine contamination by carbon deposits: a - D-37M, 800 h; b - D-50, 800 h; c - SMD-14, 500 h; d - UIM-6-NATI, 120 h; 1 - 3% TsiATIM-339; 2 - 5% AzNII-7; 3 - 6% VNII NP-360; 4 - Heavy-duty (imported); 5 - Series 1 (Soviet); 6 - Series 1 (imported); 7 - tolerable contamination limit.

The test specimens of additive VNII NP-360 possess the best detergent properties in comparison with the industrial additive. Here the additive developed by the Novo-Gor'kovskiy Petroleum Refinery is much inferior to the Orenburg NMZ [refinery?] additive, as confirmed by the test results on engine D-48 and the PZV device (Table 1).

Table 1. Test results for the VNII NP-360 additive.

Indicators	DS-11 + 6% VNII NP-360 (Orenburg NMZ)	DS-11 + 6% VNII NP-360 (Novo-Gor'kovskiy NPZ)
Over-all estimate, points.....	12.0	16.2
Quantity of carbon scale in slots and on rings, g.....	0.8	1.35
Detergent properties of the oil on the PZV device, points.	1	2-2.5

It was established by testing specimens of diesel oils DS-11 of Series 1 and Series 2 (groups B and Г) with additive compositions, conducted on new tractor engines D-37M, SMD-14, and D-50 under bench and operational conditions, that these oils have very significant advantages in comparison with oils containing additive VNII NP-360.

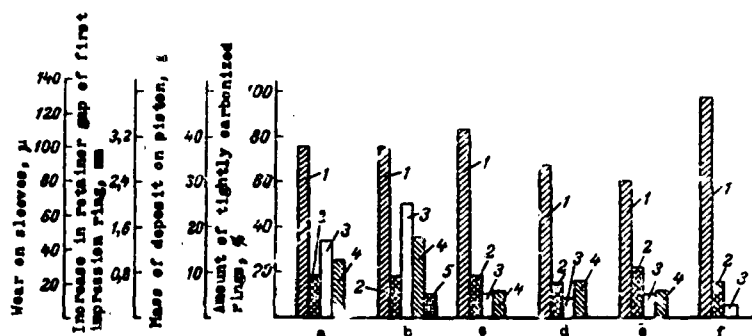


Fig. 2. Results of operational (2000 h) tests of various oil specimens on tractor diesel engines SMD-14: a - DS-11 + 6% VNII NP-360; b - DS-11 + 4.5% MNI IP-22k; c - DS-11 + composition VNII NP of Series 1; d - DS-11 + composition INKhP of Series 1; e - DS-11 + composition imported Series 1; f - DS-11 + composition VNII NP Series 2; 1 - wear on sleeves; 2 - increase in the retainer gap of the first compression ring; 3 - deposit on piston; 4 - tight rings; 5 - carbonized rings.

The best results in carbon and lacquer deposits were obtained for the SMD-14 engine under operational conditions using Series 2 oil with additive composition VNII NP. The amount of deposit on the piston was only 4 g. Series 1 oils with compositions of additives of the IKhP-AN of the Azerbaijan SSR and of the VNII NP (Figs. 1 and 2) also showed satisfactory results.

As in bench tests, diesel oil with 6% VNII NP-360 caused great accumulation of deposits and reduced the mobility of the piston rings. Testing of oils in tractor diesel engines showed that for reliable operation the overall estimate of contamination of the piston group by carbon deposits in the case of 800-h bench tests should not exceed 15 points according to GOST 11 637-65. Thus, for modern mass Soviet tractor diesel engines D-37M, SMD-14, D-50, and their modifications (of the same displacement) require oil of Series 1 (group B).

The new type of tractor engines - SMD-18, YaMZ-23NB, and others - with turbosupercharging have even greater requirements in the quality of the lubricating oil.

Bench tests of oils with different compositions of Soviet additives (VNII NP, BashNII NP, IKhP AN Azerb. SSR), as well as certain foreign oils, on engines YaMZ-238NB and SMD-18 indicated that even oils of Series 1 do not fully satisfy the requirements of these engines, particularly in their detergent properties.

The best result was obtained in testing the engine YaMZ-238NB with the Series 3 diesel oil Rimula-30, which provided an exceptionally clean piston and other engine parts. Good results were shown also by Series 2 oil with 4% BashNII-2, 4% PMS Ya, and 0.005% PMS-200A and with a composition of additives VNII NP.

Testing with the SMD-18 engine showed the indisputable advantage of oils of Series 2, which reduced piston deposits by 2.8 times in comparison with oils of Series 1 (Table 2).

Table 2. Contamination of pistons by carbon and laquer deposits (in points).

Oil with additive	YaMZ-238NB	SMD-18
	for 250 h	for 800 h
DS-11 with 6% VNII NP-360 (group B)....	39	42.5
DS-11 + 5% VNII NP-370 (group B).....	23	22
DS-11 + 11% VNII NP-370 (group D).....	8.5	7.5
Rimula-30 (Series 3).....	4	-

The operational and bench tests of these oils have shown that for reliability the long life of tractor diesel engines, particularly the more recent models, oils of Series 1 and 2 (group B and D) must be used. However, these tests were extremely drawn out (over 2-3 years and longer). These tests should be conducted under exclusive conditions, where the problem of adopting the most promising additives is solved.

Soviet and foreign tests show that the best and economically most valid method for reliable estimation and classification of motor oils is testing them on special one-cylinder installations.



By wide use of such methods, standardized in the United States and several European countries, it is possible to considerably reduce the period from synthesis of the new additive to its mass distribution to industry installation. The same methods are used abroad to control all motor oils reaching the consumer. In all Soviet standards and in MRTU's [Interrepublic Technical Specifications] the criteria of motor oil quality are still represented by numerous physicochemical and laboratory indices, most of which are unreliable in evaluating the operational properties of the oils. Not one GOST for oil has an indicator for the motor evaluation. This is one of the main reasons for the release of commercial oils of quality considerably inferior to that of the test specimens containing the same additive which has undergone engine testing with successful results.

New methods of evaluating oils for present and future tractors and other diesels have been developed by NATI, VNII NP, BashNII NP, and the IKhP AN of the Azerbaijan SSR. On the completed one-cylinder universal device UIM-6-NATI it is possible over a short period (120 h) to evaluate the motor qualities of the oils.

A method for evaluating the motor qualities of oils of groups 6 and 8 (Heavy-duty and Series 1) on the UIM-6-NATI was standardized in 1965 (GOST 11 637-65). A GOST was also confirmed for a motor evaluation method for the oils of group 7 (Series 2).

Providing the tractor fleet with winter motor oils is extremely necessary, since the coefficient of tractor use under winter conditions grows each year. There is a constant increase in the number of tractors used in regions of the Far East and Far North, where the average yearly temperature is 6-14°C below zero and where in the cold months it drops to 55-60°C below zero.

The Bakinskiy winter diesel oils Dp-8 and oils DSp-8 from sulfurous petroleums do not meet the demands for winter operational conditions for tractor diesels, especially at temperatures below -10°C, due to the unsatisfactory viscosity-temperature characteristic of these oils (Fig. 3).

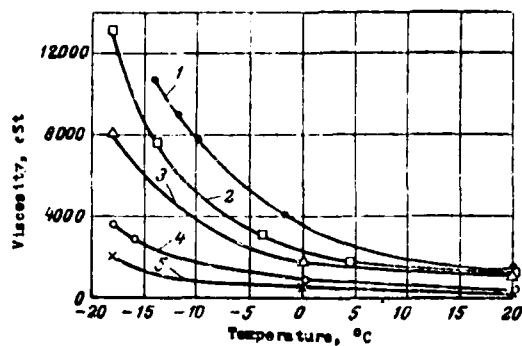


Fig. 3. Viscosity-temperature characteristic of Soviet and foreign winter oils: 1 - Dp-8; 2 - DSp-8; 3 - AKZp-10; 4 - SAE 10W-20; 5 - SAE 10W.

Tests in the Scientific Research Institute of Automotive Devices\* on winter oils Dp-8 and DSp-8 established that with a decrease in temperature the moment of cranking resistance of the D-40 engine sharply rises. Here the resistance moment for oil Dp-8 was 6 kgf·m greater than that with DSp-8 oil; at a temperature of  $-10^{\circ}\text{C}$  it is 24 kgf·m (Fig. 4), which considerably exceeds the capacity of an electric starter.

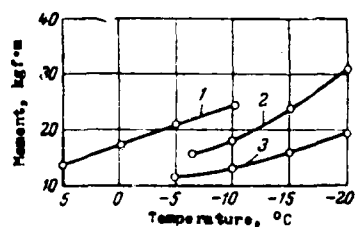


Fig. 4. Change in the resistance moment of engine D-40 (rate of rotation 200 r/m) using different oils: 1 - Dp-8; 2 - DSp-8; 3 - AKZp-6.

To provide reliable and easy starting of engines at low temperatures thickened oils with a viscosity index of 140 and higher and a pour point of  $40-50^{\circ}\text{C}$  below zero and lower are used abroad. Soviet specimens of thickened diesel oils successfully passed bench and operational tests on tractors under harsh climatic conditions.

\*NII Avtopriborov - Scientific Research and Experimental Institute of Automobile Electrical Equipment, Carburetors, and Instruments.

The use in tractor diesel engines of low-viscosity oils, thickened by polymers, with effective detergent additives will facilitate tractor operation under winter conditions, increase engine power, and considerably reduce the expenditure of diesel fuel.

#### Conclusions

For improving the reliability of tractor diesel engines the following are necessary.

1. A tractor fleet with older model diesel engines D-54, D-48, KDM-46, and others should be provided with oils containing 6% VNII NP-360 or 6% BFK.
2. A tractor fleet with recent model diesel engines D-37M, D-50, SMD-14, AM-01, and others should be provided with oils of Series 1 (group B), while engines SMD-18, YaMZ-238NB, and others with a turbosupercharger should use Series 2 oils (group Г).
3. A tractor fleet used under winter conditions at air temperatures to  $-10^{\circ}\text{C}$  should be provided with winter oils DS-8 (M-8B and M-8B) according to GOST 8581-63, and at lower temperatures, with thickened oils of the DSZp-8 type with effective composite additives.
4. The quality of commercial motor oils which are produced should be controlled through motor tests on one-cylinder UIM-6-NATI devices according to a standardized method (GOST 11 637-65).

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1. ORIGINATING ACTIVITY (Corporate author) Foreign Technology Division Air Force Systems Command U. S. Air Force		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP
3. REPORT TITLE QUALITY REQUIREMENTS OF MOTOR OILS FOR MODERN TRACTOR DIESEL ENGINES		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Translation		
5. AUTHOR(S) (First name, middle initial, last name) Arabyan, S. G., Belyanchikov, G. P., and Yershov, N. V.		
6. REPORT DATE 1966	7a. TOTAL NO. OF PAGES 9	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO.	8b. ORIGINATOR'S REPORT NUMBER(S) FTD-HT-23-283-70	
b. PROJECT NO 72301-78	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.		
d.		
10. DISTRIBUTION STATEMENT Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.		
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Foreign Technology Division Wright-Patterson AFB, Ohio	
13. ABSTRACT  Motor oils with additives VNII NP-360, MNI IP-22k, and BFK cannot ensure fully reliable work of modern tractor diesel engines, and oils with TsiATIM-339 and AzNII-7 additives are not suitable for them at all. Contemporary use of Series No. 1-3 oils in modern engines minimizes the carbon and lacquer formation, fouling of piston rings with coke, as well as corrosion due to S-contg. fuel, and ensures increased oil life (up to 500 hrs.) and engine serviceability. The following additives were suggested for enhancing of the efficiency of tractor diesel engines: 6 percent VNII NP-360 or 6 percent BFK only for older D-54, D-48, KDM-46 etc. engines, Series No. 1 (domestic MV group) oils for more recent D-37M, D-50, SMD-14, AM-01 etc. engines, and Series No. 2 (domestic MG group) oils for modern SMD-18, YaMZ-238NB etc. engines with auxiliary air turbines. Tractor diesel engines that operate at temps. above minus 10 degrees require DS-8, M-8B, or M-8V winter oils (GOST 8581-63), and those operating at lower temps. require thickened DSZp-8 oils with efficient composite additives. Quality of the oils should be checked by motor tests on the single-cylinder UIM-6-NATI app. after GOST 11 637-65. [AT0005993]		

DD FORM 1473  
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Security Classification

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Security Classification

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KEY WORDS

Diesel Engine  
Tractor  
Lubricant Additive  
Diesel Fuel

LINK A

LINK B

LINK C

ROLE

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